Scientists develop software to simulate material deformation and failure

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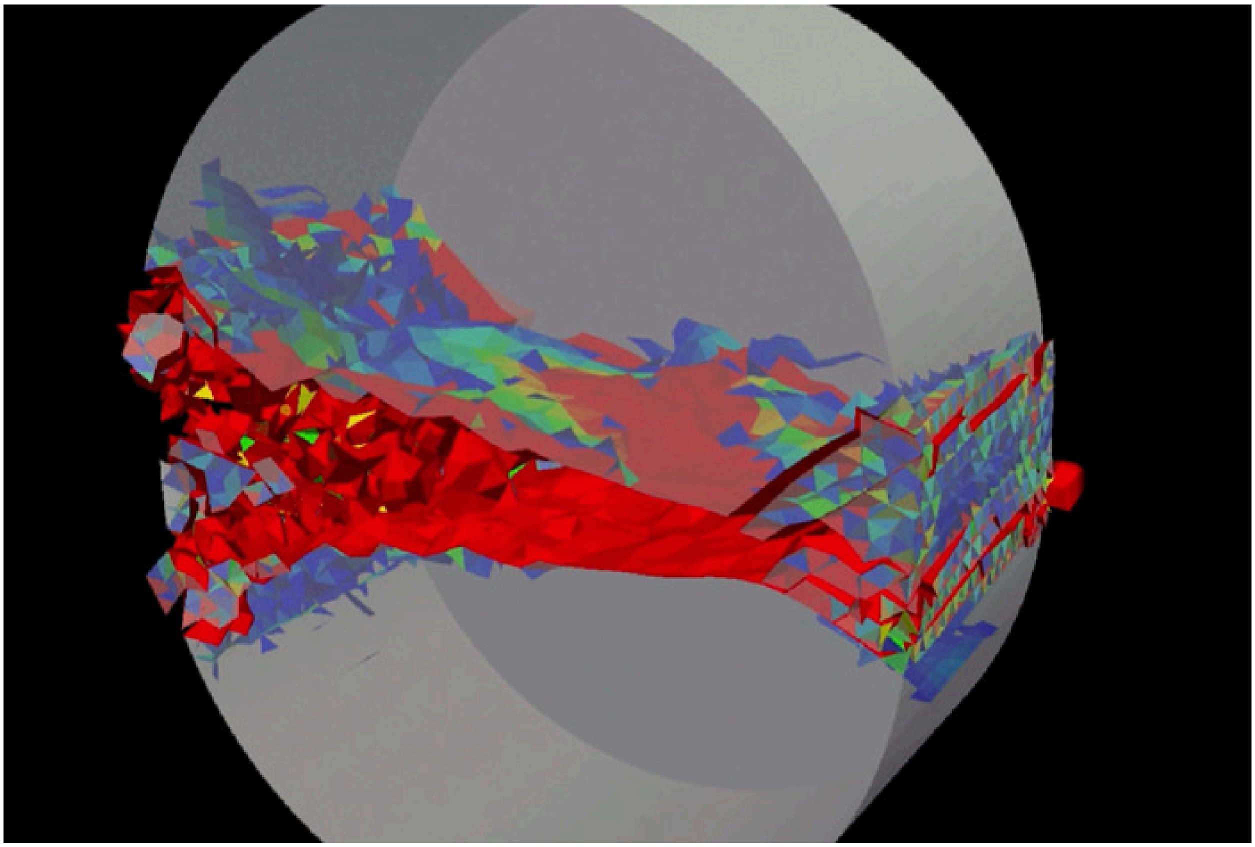

Scientists at Los Alamos National Laboratory have developed a software suite that provides the ability to predict deformation and failure of materials in a variety of situations. They range from micro-scale analysis of granular systems to earthquake rupture. Materials ranging from rocks to concrete, metals, rubbers and biomedical materials such as bone and blood cells can be analyzed using this tool. The software tool is called HOSS, Hybrid Optimization Software Suite.

HOSS is a hybrid approach that, for the first time, combines finite-element and discrete-element methods with an all-regime computational fluid dynamics solver. The finite-element method is used to examine how a material responds to deformation, while the discrete-element method analyzes material failure in the form of fracture and fragmentation, think of a glass breaking as it hits the floor. Finally, the computational fluid dynamics solver is used to analyze fluid flow inside, around and through a solid. Combining these tools has resulted in a very modular and powerful system that can operate from desktop environments to high performance computing platforms.

The potential uses for HOSS are quite varied. Geologic applications include rock fragmentation, oil and gas hydrofracture operations, well bore integrity in oil and gas well drilling, mining problems such as landslides, integrity of underground mines and other structures, meteorite impact and simulating earthquakes.

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An example of a HOSS simulation to determine the tensile strength of a geomaterial.

Other applications are national security related, such as the analysis of ultra-high strain rate events like underground nuclear explosions, building collapse as well as metal brittle failure. Other areas where HOSS can be applied are modeling of bone fractures and biomedical applications such as red blood cell flow analysis.

In addition to the above listed capabilities, HOSS features one ground-breaking module (HOSSFlow) that has the ability to model fluid flow in a variety of regimes: from subsonic to supersonic flow, from frictionless to frictional flow, from compressible to incompressible flow and from low to high Reynolds' numbers flow. In other words, HOSSflow can resolve the flow of honey from a jar to the exhaust of a turbine engine.

An added feature of HOSS is the high efficiency of the software. This is accomplished by a specially designed, platform independent parallelization framework. This enables the technology to obtain an overall speed-up of 30,000 times when compared to other standard single-processor implementations.

In summary, HOSS is a game changer; it can generate accurate simulations of complex problems concerning materials deformation and failure. HOSS expands the ability to do "virtual experiments" that would be impossible in a laboratory or a real world setting. For example, HOSS could be used to predict a building's response to an explosive load thus enabling engineers to design structures that minimize occupants' danger. The variety of problems that can be modeled is incredibly broad and HOSS can provide answers to questions that are not easily attained otherwise.

For further information, contact Earl Knight.

Caption for image below: This HOSS simulation shows a cluster of general-shape 3D particles interacting with each other.